

February 21, 1997

Dear Tank Owner or Operator/Corrective Action Specialist/Project Manager:

The Petroleum Storage Tank Division has developed new guidance for the delineation of soil and groundwater contamination and case closure criteria at leaking petroleum storage tank (LPST) sites. Please review the enclosed February 10, 1997 memos entitled *Process for Closure Evaluation for Petroleum Hydrocarbon LPST Sites Exceeding Target Concentrations* and *Guidance for Judging the Adequacy of Contaminant Delineation for Purposes of Determining if Further Corrective Action Is Needed*, and the Questions and Answers information in detail. Questions may be directed to the PST Division after you have completed your review.

The new closure and plume delineation criteria may significantly influence the course of action that should be taken for an LPST site. In some instances cases may now be eligible for closure that previously would not have been. These new criteria should be taken into account when determining the next appropriate step of corrective action subsequent to the completion of a Risk-Based Assessment.

At this time, tank owners and operators should pause on work in progress and have their Corrective Action Specialist review the information available on their cases and determine whether the delineation and closure criteria are met for each LPST case using the new criteria. Site closure requests should be submitted on cases which meet the closure criteria. Any proposal for the next appropriate step on cases that do not yet meet the closure criteria should incorporate these guidelines. The TNRCC will also utilize these guidelines as it issues approvals or direction for further work. *Please note that work done after April 11, 1997 that does not conform to these new guidelines may be at risk for reimbursement eligibility.*

Please keep in mind that another deadline is approaching in December 1997 that may affect the tank owner and operator's deductible for reimbursement. The deadline requires the completion, submittal, and approval of a Corrective Action Plan for site remediation. If these activities are not accomplished by December 22, 1997, the deductible contribution will be four times the original deductible. Many LPST cases will be closed prior to this deadline and will not need to go through these actions. Therefore it is in the tank owner and operator's best interest to continue as quickly as possible necessary work on LPST cases. Please refer to the rules in Title 30, Texas Administrative Code, §334.312 for specific information on the changes in the deductible.

We appreciate your cooperation in this matter. Please contact the PST Responsible Party Corrective Action program at 512/239-2200 should you have any questions.

(Signed 2/21/97)  
Anton Rozsypal  
Manager  
Responsible Party Investigations Section

(Signed 2/21/97)  
Danny Lien  
Manager  
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## Questions and Answers

These questions and answers have been developed to address anticipated questions regarding the February 10, 1997 memos entitled *Guidance for Judging the Adequacy of Contaminant Delineation for Purposes of Determining if Further Corrective Action Is Needed* and *Process for Closure Evaluation for Petroleum Hydrocarbon LPST Sites Exceeding Target Concentrations*. If you still have questions after reviewing all of the information in detail, please contact the PST Corrective Action program at 512/239-2200.

- 1. Q. What prompted this new guidance? How do I obtain a copy of the BEG report?**

**A.** The Bureau of Economic Geology at the University of Texas at Austin conducted a study of groundwater contaminant plumes from leaking petroleum storage tank sites in Texas. The title of the report is *Extent, Mass, and Duration of Hydrocarbon Plumes from Leaking Petroleum Storage Tank Sites in Texas*, Geological Circular 97-1. This report documents that petroleum hydrocarbon plumes typically naturally attenuate. Cost of this publication is \$4.50 plus tax and shipping. The phone number for BEG's publication office is 1-888-839-4365 (toll free) or 512-471-7144.
- 2. Q. I haven't done any work on my LPST site in quite a while. What is the next step I should take?**

**A.** A registered Corrective Action Specialist (CAS) should be hired to evaluate the information available on your site. A list of registered Corrective Action Specialists can be obtained from the TNRC C Occupational Certification Section at 512/239-2192. The CAS will propose the next appropriate step based on the specifics of the case, the enclosed guidance, and all other guidance and rules of the PST program.
- 3. Q. How do I use the decision flowcharts?**

**A.** Figures 1 and 2 are decision flowcharts for groundwater exposure pathways and Figure 3 is for soils exposure pathways. Use site-specific information to determine whether the answer is Yes or No for each decision point in each applicable flowchart, and continue through the flowchart until an endpoint is reached. All pathways applicable to a particular site must be evaluated. Figure 1 must be used when there is a documented groundwater impact. Figure 2 must be used in addition to Figure 1 when the depth to groundwater is less than or equal to 15 feet **or** is within the typical construction depth for that area. Never use only Figure 2 to evaluate groundwater pathways. Figure 3 must be used for all cases. In Figure 3 "Soils Pathways," there are three paths (paths 1, 2, and 3). All three paths must be evaluated in the flowchart.

The decision flowcharts should be used to guide the LPST case towards closure. Reports submitted following each phase of corrective action should include a proposal for the next appropriate step of corrective action based on the decision flowcharts. Corrective action activities should concentrate on only those potential exposure pathways that are of concern for a particular site. The workplan should refer to the applicable path(s) in the decision flowcharts as justification for the proposed activities.

Please refer to the memo *Process for Closure Evaluation for Petroleum Hydrocarbon LPST Sites Exceeding Target Concentrations* for additional information on the use of the flowcharts.
- 4. Q. The decision flowcharts have boxes labeled "close." What does this mean and what do I do when this is the appropriate step?**

- A. “Close” means that the particular exposure pathway does not appear to be a risk to human health and safety. If the decision flowcharts indicate that “close” is the final step for **all** pathways (soil and groundwater, as applicable), the *Site Closure Request* form (TNRCC-0028 dated 9-1-96) should be completed and submitted along with any other supporting documentation that was not previously submitted on the case. Include copies of the decision flowcharts with the flowchart paths marked by circling Y or N for each step in the flowchart applicable to that particular case.

**5. Q. How do I document that the case is ready for closure?**

- A. Copies of the decision flowcharts should be included with the *Site Closure Request* form (TNRCC-0028, 9-1-96 version) when LPST case closure is appropriate. On each flowchart, indicate the flow path applicable to that LPST site by circling either the Y or N for each decision point on the flowchart. Section VI of the *Site Closure Request* form should be used to document or justify each decision point. For example, include a reference to a page/paragraph of a previously submitted report that contains the documentation for the decision, or provide additional information beyond that previously submitted. If a *Site Closure Request* form has previously been submitted and is awaiting review, it is not necessary to submit the flowcharts. In situations where the case can be closed in accordance with the immediate exit criteria, include justification in Section VI of the *Site Closure Request* form.

**6. Q. The decision flowchart says to continue corrective action. What activities would this include?**

- A. Please refer to item #7 on page 2 of the memo *Process for Closure Evaluation for Petroleum Hydrocarbon LPST Sites Exceeding Target Concentrations*. Additional corrective action may include additional assessment and/or monitoring, a Plan B evaluation for the pathway(s) that did not “close,” site cleanup (using either engineered systems or natural attenuation), implementation of an institutional control, or a combination of these activities depending on the site-specific information available. In some instances it may only be collecting information to better address the closure criteria decision points. The next appropriate step should include only those activities necessary to move the case towards closure for the particular pathway(s) of concern.

**7. Q. A box in Figure 3 says “Reevaluate considering soil type, precipitation & depth of groundwater.” How should this reevaluation be conducted and how much will I be reimbursed for this activity?**

- A. An appropriate fate and transport model should be used for this determination. At this time, the TNRCC will not specify a particular model that must be used. The reimbursable cost for personnel time for this activity is actual cost up to \$760. Please do not submit a proposal for this activity. However, this activity should be conducted only when arriving at this decision box in Figure 3 or when it can otherwise be justified as warranted for closure. The TNRCC is considering the future adoption of the Soil Attenuation Model described in the *Texas Risk Reduction Program Concept Document* dated December 16, 1996 (available from the TNRCC’s Internet Web page). If this occurs, the TNRCC will make interested parties aware of this decision.

**8. Q. Figure 2 is to be used when groundwater is less than 15 feet deep or is within typical construction depth. Under what conditions may this depth be modified from the 15 foot standard?**

- A. The concern in this exposure pathway is the potential for construction workers to be exposed to

contamination due to inhalation of vapors from or dermal contact with the contaminated groundwater. If construction is never conducted in the area to a depth of 15 feet, then justification for the modified depth can be submitted. For example, if excavation is never conducted in the area below 8 feet due to an impenetrable rock layer, then this justification can be used for modifying the potential exposure pathway. Alternatively, if construction is typically conducted to depths greater than 15 feet (such as areas where utility lines are installed at greater depths) and groundwater is encountered within that zone, then this pathway must be examined even though the depth to groundwater is greater than 15 feet.

9. Q. **Figure 2 mentions protective concentrations for construction worker exposure. What are these concentrations?**
- A. These concentrations are based on the combined exposure risk from contaminated groundwater due to dermal contact and inhalation of volatile emissions. Further guidance will be forthcoming regarding this and other issues in RG-36.
10. Q. **How much will be reimbursed to have the case reviewed for closure?**
- A. At each step of the corrective action process, the Corrective Action Specialist should determine the next appropriate step. This evaluation should always include a determination of whether the case is ready for closure. The enclosed guidelines will streamline the process by providing the CAS with specific criteria and guidance, enabling the CAS to expedite the review of the case. If case closure is appropriate, the cost of completing the *Site Closure Request* form (\$250) will be reimbursed assuming all eligibility criteria are met. Preapproval for this activity is not required. If the case is not ready for closure and some other corrective action activity is proposed as the next step, no additional costs for determining the next action will be reimbursed beyond that allowed for development of a cost proposal and workplan. Please do not submit a workplan or cost proposal to review the case under this new closure criteria.
11. Q. **If the tank owner or operator wishes to conduct more assessment or to clean up the site at levels below those required by the TNRCC, will she/he be reimbursed for those activities?**
- A. No. Reimbursement will be made on eligible sites for only those corrective actions that are deemed necessary by the TNRCC. Tank owners and operators may certainly conduct whatever activities they deem appropriate beyond TNRCC requirements at their own expense, provided these activities are conducted within all applicable regulations.
12. Q. **In the table attached to the memo entitled *Guidance for Judging the Adequacy of Contaminant Delineation for Purposes of Determining if Further Corrective Action Is Needed*, Groundwater Scenario 2 says modeling may be used to project the concentration at 1200 feet from the site. How much will I be reimbursed for this activity?**
- A. The reimbursable cost for personnel time for this activity is actual cost up to \$480. This activity should be conducted under this scenario when the site is a Priority 3.5 or the impacted groundwater is a local supply, or there is an existing water supply well downgradient beyond 1200 feet but within

0.5 miles. Please do not submit a proposal for this activity. This activity should not be conducted unless necessary.

**13. Q. My Corrective Action Specialist has already started work on the Plan B report. Should I direct them to finish the report? If not, how much will I be reimbursed for the work already completed?**

**A.** The criteria set forth in the attached documents should be used to evaluate the case and determine whether completion of a Plan B is necessary. Once it has been determined that the Plan B is needed, the report should be completed and submitted. If the determination is made that a Plan B is not needed (i.e., all pathways are closed through the closure criteria evaluation), then work on the evaluation should end immediately or no later than **April 11, 1997**. In the instance when certain pathways cannot be closed under the closure criteria, then the completion of a Plan B should focus on those pathways.

Reimbursement will be provided for necessary activities accomplished on eligible sites. In the case of incomplete Plan B evaluations, reimbursement will be made on the work completed up to **April 11, 1997**. Documentation of the work completed must be submitted with the application for reimbursement, including copies of all completed components of the Plan B report. Please do not submit partial reports to the RPR/RPI Sections. Partial reports will be used only to accompany reimbursement applications to document the amount of work done prior to **April 11, 1997**.

**14. Q. How does this affect Plan B's?**

**A.** Cases with Plan B's at the TNRCC will be reviewed against these new closure criteria first. Then, the Plan B will be evaluated in the context of those conclusions. In the future, Plan B's will focus on only those exposure pathways which could not be eliminated through the new closure criteria. It is likely that fewer Plan B analyses will now be required than if the TNRCC did not develop the new closure criteria.

**15. Q. Additional assessment (beyond that conducted for a Risk-Based Assessment) and/or groundwater monitoring work has been preapproved. Should the consultant continue with that work?**

**A.** The Corrective Action Specialist (CAS) should review the information available on the case in terms of the new closure and plume delineation criteria. When the field work has already been conducted, complete the report of activities and submit the report as approved. If the field work has not yet been conducted, but is still necessary based on the new criteria, continue with the preapproved scope or, if appropriate, a lesser scope of work. If the additional work is not necessary according to this new criteria, the work should not be performed. If other activities are necessary to move the site towards closure, these activities should be proposed (if the site is eligible for reimbursement). Failure to terminate work could result in reimbursement disallowance.

**16. Q. What are the surface water target concentrations?**

**A.** Information on surface water target concentrations can be found in the surface water quality rules in Title 30, Texas Administrative Code, Chapter 307. Surface water is considered as a potential

receptor when a stream or other surface water is hydrologically connected with the impacted groundwater.

**17. Q. Should a walking receptor survey be conducted beyond the standard 500-foot radius survey of the site?**

**A.** No. A walking receptor survey beyond the 500-foot radius required per RG-175 for all sites should not be conducted unless directed by the case coordinator if the costs of the work are to be reimbursed.

**18. Q. How much data is needed to determine whether a groundwater plume is stable or declining?**

**A.** Stable/declining plumes are plumes in which concentrations are not increasing in aerial extent. If target concentrations have not been met, normally four groundwater monitoring events are needed to document plume stability. Some sites may require more than four monitoring events. If plume migration is apparent, additional site assessment and corrective action may be necessary.

**19. Q. When considering water wells near the site, which water wells are of concern?**

**A.** Any water well within the specified distance (500 or 1200 feet) from the site that is completed in the impacted zone or any water well that is completed in an aquifer that is hydrologically connected to the impacted zone is potentially of concern for purposes of plume delineation. Also consider any water well where the cementing information is either not available or the cementing information indicates that there may be a connection between the impacted zone and the open portion of the water well. Water wells located downgradient from the site should be of particular concern; however, water wells located in any direction from the site should be included in the determination. Do not include monitor wells as potential receptors.

The location of a well relative to the contaminant transport direction should be considered. Generally, the plume should be defined as per the February 10, 1997 memo entitled *Guidance for Judging the Adequacy of Contaminant Delineation for Purposes of Determining if Further Corrective Action Is Needed* in the direction of the water well to determine if the water well is affected or threatened. The plume delineation may be able to verify that upgradient wells or wells located laterally from the source are not of concern and with minimal assessment could then be dropped from the decision basis. Primary emphasis should be placed on downgradient wells that could be affected should plume expansion continue.

**20. Q. I have a site which is prioritized as a 4.0 or an alpha-numeric priority (for example, 4A, 2A, etc). Should I evaluate my site for closure using the new criteria?**

**A.** If your case is prioritized as a 4.0 or an alpha-numeric priority (our pre-1993 priority scheme), then there may not be enough information on your site to evaluate the site under the new closure criteria. For example, a 500-foot radius walking receptor survey and adequate assessment must have been completed in order to classify your site under the newer risk-based priority scheme. You will need to hire a registered Corrective Action Specialist to determine the next appropriate step needed for your case and submit a proposal for those activities. Once adequate information is obtained on your site, the case may be evaluated under the new closure criteria.

21. Q. **Should I resubmit a *Site Closure Request (SCR)* form if I have already submitted one but have not yet received a response from the TNRCC?**
- A. Unless new information or additional justification for closure will be provided, it is not necessary to resubmit an SCR. If additional information or justification is now available, a revised SCR should be submitted. A workplan and cost proposal for the next appropriate step of corrective action should be submitted if the site cannot be closed under the new closure criteria.
22. Q. **What does "closure with controls" mean?**
- A. Under the scenarios in the decision flowcharts, "closure with controls" refers to institutional controls, such as deed recordation. For example, closure of a potential exposure pathway may be appropriate with an institutional control to prevent future use of groundwater at the site. Please refer to the rules on institutional controls in Title 30, Texas Administrative Code, §334.205-334.208. In lieu of controls, cleanup via an engineered solution or natural attenuation will be needed to reduce concentrations to standards. Controls would be the minimal criteria to qualify for immediate closure.
23. Q. **Will the TNRCC reopen a previously closed LPST case if contaminant levels are later found above action levels on a neighboring property?**
- A. No, unless additional information is discovered which indicates an unacceptable risk to human health or safety. The existence of contamination does not necessarily present an unacceptable risk. Justification for closure of an LPST case as documented by the Corrective Action Specialist should always include an evaluation of the entire area of concern regardless of property boundaries. This justification for closure includes the elimination of all potential exposure pathways such that the remaining contamination is protective of human health and safety, either because the concentrations are protective or because there is no exposure pathway. The case would only be reopened if there is an exposure pathway of concern.
24. Q. **The TNRCC guidance document *Risk-Based Corrective Action for Leaking Storage Tank Sites* includes information on plume delineation that is different from that in the February 10, 1997 memo. Which document is correct?**
- A. The February 10, 1997 memo "Guidance for Judging the Adequacy of Contaminant Delineation for Purposes of Determining if Further Corrective Action is Needed" supersedes all previously issued guidance on plume delineation.
25. Q. **At what point do I use Figure 4?**
- A. Figures 1, 2, and 3 may lead to a need for further corrective action for a site. The urgency of this corrective action depends on the likelihood of exposure in the short term. Where there is time, natural attenuation may be a suitable corrective action. The decision flowchart in Figure 4 provides guidance for situations where natural attenuation may be an appropriate alternative to engineered remediation systems at LPST sites where additional corrective action is warranted. An appropriate remediation alternative can be determined following the completion of adequate assessment and determination of target concentrations.

**26. Q. What does “abate expansion” mean?**

**A.** There are several methods of preventing further plume expansion, including containment, source removal, and groundwater pumpage. The most appropriate method must be determined based on the specifics of the particular site.



# Texas Natural Resource Conservation Commission

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## INTEROFFICE MEMORANDUM

**To:** PST Corrective Action Coordinators      **Date:** February 10, 1997

**Thru:** Joe D. Woodard, Director      Danny Lien, Manager  
Petroleum Storage Tank Division      Responsible Party Remediation Section

Anton Rozsypal, Manager      Jackie Hardee, Manager  
Responsible Party Investigations      State Lead Remediation Section

**From:** Chet Clarke, Director of Programs  
Petroleum Storage Tank Division

**Subject:** Guidance for Judging the Adequacy of Contaminant Delineation for Purposes  
of Determining if Further Corrective Action Is Needed

The purpose of assessing sites is to gain adequate understanding of the nature and distribution of the contamination and site characteristics to determine if the release poses a threat to the public and environment. There can be a low threat potential because of low contaminant levels or because there is no potential for receptors to be exposed. Historically, the PST program has typically required the "full delineation" of sites regardless of the presence or absence of receptors. Guidance is provided herein for when to accept lesser plume delineation for petroleum hydrocarbon releases from leaking storage tanks. This guidance provides the site coordinator the direction to use site-specific judgements considering at least the below listed criteria to evaluate adequacy of contaminant definition. Some of the criteria are based on findings of the Bureau of Economic Geology (BEG) study of LPST plumes. The goal is that some of the low risk sites which may have been stalled and prevented from closing in the past due solely to the lack of full delineation may now close.

### **NAPL:**

The full extent of NAPL should be determined.

### **Soil Contamination:**

#### Vertical Delineation of Soil Contamination:

The purpose of the vertical delineation of the release is to determine if groundwater is threatened or impacted. Attention to the adequacy of the soils investigation for the soil-to-groundwater pathway should be particularly acute in areas where there is a high incidence of groundwater receptors. In situations where the release was discovered by a documented impact to groundwater, or where analysis of soil samples is not possible, then investigations should continue to the water table.

Vertical definition should be appropriate given the location of the source and the site stratigraphy. The vertical investigation should be focussed at the point of release, or the area of highest soils contamination as documented by tank removal information. Investigations which do not extend to

below the depth of the point of release, or to the deepest portion of the tank system when the point of release is unknown, should not be considered acceptable. Additionally, vertical delineations which focus only in areas remote from the source and do not continue to groundwater; or do not adequately accommodate the likely migration characteristics for the site should generally be considered unacceptable. For example, a release of fuels to the Ogallala aquifer tends to migrate essentially straight down with minimal lateral spread (interception of a caliche layer may induce some lateral spread), and unless the investigation targets the immediate proximity of the point of release, the problem may be missed.

The vertical delineation should continue to at least 5 feet past the depth at which the limits of soil contamination is reached (no concentration apparent) as indicated by field observations and field screening, or until the water table is intercepted (if DNAPLs are of concern at a site, then the vertical delineation should continue past the water table). **It is not appropriate to use Plan A soil-to-groundwater concentrations as vertical definition criteria.** If subsequent laboratory analysis indicates that the vertical extent has not been defined, base the need for further delineation on the likelihood that groundwater has been affected (e.g., nature of release source, depth to groundwater from known vertical extent, site geology, the permeability of the material, concentration levels, distribution and trends), the sensitivity of the underlying groundwater, and the proximity of groundwater receptors.

#### Lateral Delineation of Soil Contamination:

Plan A concentrations are generally suitable for lateral delineation regarding human health and soil-to-groundwater pathways. However, other hazards such as impacts to utilities or generation of explosive atmospheres should be specifically evaluated. At least one sampling point should be located in the area of probable maximum contamination within the upper 15 feet of soils to determine if human health protective concentrations have been exceeded. Results of samples collected during tank removals should be part of the evaluation.

In some instances, the presence of impermeable surfaces which act as exposure barriers may be used to limit the lateral extent of the investigation when those surfaces are likely to remain intact over the long term (either with or without institutional controls), and the soil-to-groundwater pathway or explosive atmospheres are not of concern. The investigation may be adequate so long as it can be demonstrated that protective concentrations exist in areas beyond the extent of cover, and that the cover will remain intact. The BEG study reports that 90% of the sites studied have greater than 50% on-site impervious cover.

Consideration should also be given to the possibility that subsurface conduits (e.g., subsurface utility runs) may be providing preferential pathways for contaminant migration. This may be of particular concern where the site soils are clays or other low permeability material, and the utility fill is of much higher permeability. When the presence of an impermeable surface is the basis for not requiring further evaluation, and ultimately a condition for closure, then at least set out such conditions for closure in the *No Further Action* letter if an institutional control is not required.

Note: The BEG study reports the area of contaminated soil is less than 6,750 ft<sup>2</sup> at the 50th percentile and less than 15,000 ft<sup>2</sup> at the 75th percentile. Assuming a square surface area, this translates to 82 feet (6,750 ft<sup>2</sup>) and 122 feet (15,000 ft<sup>2</sup>) respectively on a side.

#### **Groundwater Contamination:**

The extent of groundwater plume delineation depends on the presence or absence of groundwater

receptors (e.g., water wells, surface water bodies, utility workers), and the distance and location of the point(s) of exposure relative to the source. To be a groundwater receptor, there must be a reasonable potential for exposure to the release. For example, supply wells which are screened in a separate, deeper groundwater zone and properly sealed such that cross-communication between the affected groundwater zone and deeper zone is prevented, should not be likely receptors. Because different receptors/exposure pathways carry different protective concentrations, it is not appropriate to always require groundwater plume definition to be conducted to the same concentrations (historically drinking water standards). For threats to existing water supply wells, the plume should be defined to one order of magnitude less than the drinking water standard, or to the lowest EPA Method PQL for the chemical of concern, whichever is higher (e.g., benzene - 2 ppb; ethylbenzene - 70 ppb; toluene - 100 ppb; and xylenes - 1 ppm). This is an amendment to the criteria listed in RG-36. When the affected groundwater is currently unused, but has a likely future use, then the plume should be defined to the Plan A Category I groundwater levels (drinking water levels). For situations where shallow groundwater intercepts local utilities (generally  $\leq 15$  feet or the typical construction depth for an area), then the plume should be defined to the protective concentration for construction worker exposure to groundwater. Where surface waters are threatened, then surface water standards should be used as delineation criteria. Where vapor intrusion into buildings is of concern, then those protective concentrations should be applied in the areas where the plume extends beneath buildings. (Note: Before plume delineation is based on this criteria, vapor monitoring should occur to verify that the groundwater is generating unprotective vapors.) Other exposure conditions may be relevant to a site and those should be specifically addressed. Obviously, where different receptor types are present, delineation may be focussed in different areas and be based on more than one criteria. The receptor survey conducted by the responsible party/Corrective Action Specialist should guide delineation issues.

The BEG study indicates that groundwater benzene plumes (defined as 10 ppb benzene in the study) are usually less than 380 feet in length (90% of sites studied) and are almost always less than 1,200 feet in length (99% of sites studied). Additionally, over 85% of the time, both plume length and average concentrations are naturally stabilized or declining. Insights drawn from the study and the following guidelines should be considered when determining the adequacy of groundwater plume delineation (See Groundwater Plume Delineation Table for summary). (Distances are primarily focussed in relation to the direction of plume migration, but there is potential for wells installed upgradient or lateral of the source to influence gradients and draw contaminants).

#### Existing Groundwater Receptors:

When existing water supply wells or surface waters are located within 1200 feet of the source, or existing utilities are located within 500 feet of the source, the investigation should be continued out to the points of exposure for the receptor(s) or to the protective concentrations relevant to the particular receptor/exposure pathway, whichever is closer. When the 0.5 mile water well survey identifies existing water wells which are located beyond 1200 feet downgradient of the source and draw water from the affected zone, then a conservative modeling evaluation should be conducted to project the benzene concentration at the point of exposure. If the predicted concentration exceeds the protective concentration for the receptor, then plume delineation is needed. Assume a benzene half life of 5 years. Verify plume stability.

#### Probable Future Groundwater Receptors:

When future receptors are likely to develop within 500 feet of the source, the investigation should be continued out to likely points of exposure for the receptor(s) or to the protective concentrations relevant to that particular receptor/exposure pathway, whichever is closer. The 500 foot criteria may be shortened if a reliable groundwater modeling evaluation suggests the protective concentrations relevant to the particular future receptor/exposure pathway will extend to a lesser distance. The potential for future receptors to develop may be unlikely when the groundwater affected is not a prolific aquifer, there is no historical use of the affected groundwater zone, a municipal supply is available which is not sourced from the contaminated groundwater zone, and groundwater is deeper than typical construction depths. Also, there may be land surface features such as the presence of highways, large buildings/developments, or heavy industrial areas which may effectively preclude future groundwater development in the area. Existing legal prohibitions/ordinances against the installation of water wells may also be a reasonable basis for assuming there will be no future receptors. Typical construction depths and current land use trends may give some insight as to whether future construction worker exposure is likely. Verify plume stability.

#### No Current or Probable Future Receptors:

When there is an absence of receptors within 1200 feet of the source and the potential for future receptors to develop within 500 feet of the source is considered to be low, then delineation completed to the Category III levels should be accepted as adequate delineation. If plumes are not defined to Category III levels, then a decline in concentrations with distance from the source should be documented to ensure the source area has been identified. Always keep in mind site-specific factors which could attribute to the development of plumes which could extend beyond these distance cutoffs (e.g., very large releases, large extent of NAPL, fracture or karst controlled systems, preferential flow pathways, etc).

When maximum concentrations exceed Plan A Category III levels, then the stability of the plume should be verified.

#### Special Considerations:

Efforts should be taken to define the plume when impacts to karst or fracture control systems occur. However, investigations to delineate the extent of the plume and the groundwater flow direction in such terrain may prove highly unreliable and infeasible. Assumptions from the BEG study may be irrelevant to such non-porous media environments. The source area should be investigated to determine the need for and feasibility of source abatement.

This guidance provides general criteria for acceptable contaminant delineations. In the implementation of this guidance, exercise a degree of caution when determining if a plume has been adequately defined. The extent of the investigation should be evaluated for adequacy in the context of the hydrogeologic environment, the location of the source area, chemical properties, documented impacts, and other site-specific information that may be available. It is more desirable to periodically require more plume delineation than may have been truly warranted, than to miss the problem because of inadequate information. These criteria should not be used in lieu of common sense, and these criteria should not be viewed as de facto requirements. When there is good technical justification, coordinators should exercise their discretion to require more or less investigation beyond these criteria. Coordinators should confer with their supervisor when unsure about the appropriate degree of delineation for a given situation.

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Chat Clarke

cc: Susan Bredehoft, TNRCC, Field Operations Division  
Danny Neal, Manager, PST Reimbursement Section  
David Bower, TNRCC Enforcement Section - PST

### Groundwater Plume Delineation Criteria

	Groundwater Scenario	Delineation Extent
1	Existing water supply well within 1200 feet of source area.	Define to POE; or to 1 order of magnitude less than Plan A Category I level or PQL, whichever is greater concentration. Verify plume stability.
2	Priority 3.5 or local supply, or 0.5 mile water well survey indicates an existing water supply well downgradient beyond 1200 feet	Use modeling to project concentration at 1200 feet. Confirm stable or declining trend. Modeling result should not exceed Plan A Category I concentrations.
3	Probable future groundwater use within 500 feet	Define to Plan A Category I levels. Verify plume stability.
4	Surface water within 1200 feet downgradient of source	Define to POE, or to surface water criteria. Modeling evaluation could be conducted to demonstrate protective concentrations at lesser distance. Verify plume stability. <b>(If plume defined to Plan A Category I levels, further delineation may be unwarranted unless judge potential for impact to surface water.)</b>
5	Groundwater $\leq$ 15 feet deep or within typical construction depth and existing utilities within 500 feet of source	Define to concentrations protective for construction worker exposure. Verify plume stability.
6	Groundwater $\leq$ 15 feet deep or within typical construction depth and likely future utilities within 500 feet of source	Define to concentrations protective for construction worker exposure. Verify plume stability.
7	No existing receptors within 1200 feet of source and no likely future receptors within 500 feet of source.	Accept delineation to Plan A Level Category III level as adequate. When plume is not defined to Plan A Category III criteria, then sufficient downgradient definition should exist to show declining concentrations with distance from source.  When maximum on-site concentrations exceed Category III levels, verify plume stability.
8	Fractured Bedrock or Karst Environments	Focus primarily on protection to receptors (possible monitoring likely receptors). Delineation should be attempted to Category I levels (unless an unused source), and abate source area as possible.
9	Other Exposure Pathways (groundwater to indoor air, explosive concentrations).	When these issues are of concern at sites, then delineation to protective concentrations for these pathways should occur.

#### Criteria for Likely Future Receptor:

##### Groundwater Use:

Priority 3.5 or local water supply (Note: local supply is indicated if water well survey indicates routine use of the affected groundwater body)

No Prohibitions on Use

Residential Area, particularly rural

Absence of municipal supply

Assume 5 year benzene half life.

# Texas Natural Resource Conservation Commission

## INTEROFFICE MEMORANDUM

**To:** PST Corrective Action Coordinators                      **Date:** February 10, 1997

**Thru:** Joe D. Woodard, Director                      Danny Lien, Manager  
Petroleum Storage Tank Division                      Responsible Party Remediation Section

Anton Rozsypal, Manager                      Jackie Hardee, Manager  
Responsible Party Investigations                      State Lead Remediation Section

**From:** Chet Clarke, Director of Programs  
PST Division

**Subject:** Process for Closure Evaluation for Petroleum Hydrocarbon  
LPST Sites Exceeding Target Concentrations

The Bureau of Economic Geology study of LPST groundwater benzene plumes concluded that the length of 96% of the plumes studied is stabilized or declining, and 86% of the benzene plumes studied have average concentrations which are steady or declining. Furthermore, benzene plumes (defined in the study as 10 ppb benzene) typically are limited in extent (maximum length from source: 380 feet; 90th percentile, 1200 ft 99th percentile. This suggests that the plumes are generally contained and degraded by natural attenuation conditions. Therefore, if a current exposure does not exist via the groundwater pathway, then it is unlikely that future exposure will occur due to continued contaminant migration. Rather, the most reasonable source of future exposure is within the current extent of the plume. Some groundwaters have a very low probability of future use, and therefore, of exposure due to the nature of the groundwater and/or location. To have risk, there must be both contaminants present at unprotective concentrations and potential for exposure to those contaminants. If there is no exposure potential, there is no risk.

This process is focussed on identifying those sites where future exposure potential is low such as typical Priority 4.1 and 4.2 sites. These sites may often be located in an active commercial area which has a municipal water supply not sourced from the affected groundwater zone, and which may have extensive surface cover which prohibits exposure to subsurface contamination. Further, the impacted or threatened groundwater zone in many instances is not typically targeted for groundwater supply purposes. Sites where future exposure is more likely may be sites in transition in mixed commercial/residential or residential areas, where there is a history of use of the affected groundwater zone, in more suburban/rural areas, and where there is no municipal supply or no ordinance against private well installation.

The goal of the risk-based corrective action program is to get low risk sites to closure quickly and appropriately **(preferably prior to the completion of a Plan B RBCA evaluation)** so that resources can be focussed on high risk sites. Institutional controls may provide a reasonable assurance against future exposure where exposure may otherwise occur.

The following assumptions are fundamental to this process:

1. No emergency situations exist.
2. A receptor survey has been completed.
3. Probable impact to receptors or probable imminent impact has been identified.
4. When inadequate case information is available to address decision points based on professional judgement, necessary information will be requested.
5. Site refers to all on-site and off-site affected properties.
6. Surface waters are considered receptors only when in hydrologic connection with the affected groundwater zone.

7. “Closure” or “corrective action” is referenced for each pathway. Closure of a pathway does not mean closure of the case. Only when all pathways can be closed, is site closure appropriate. A reference to “further corrective action” could be a Plan B evaluation, site cleanup (engineered or natural attenuation), or possible implementation of a control. “Closure with controls” means that placement of an institutional control would be the basis for immediate closure of the pathway. Proceeding to Plan B may be warranted, or site cleanup. Natural attenuation may be a viable alternative for many sites (see Figure 4).
8. Local supplies are groundwaters which are regularly targeted for a water supply as indicated by the water well survey. Consider frequency of use.
9. Stable/declining plumes are plumes in which unprotective concentrations are not increasing in aerial extent. This may be recognized as the concentrations in perimeter monitoring points are showing a stable or declining trend (not to consider minor fluctuation which may simply be the result of water table fluctuations), not as a result of the plume moving out of the monitoring area. This may be evaluated as the concentrations over time, or evaluating isoconcentration maps. Four monitoring events may be required to complete this evaluation.
10. The future use of groundwater should be considered likely when a state designated major or minor aquifer (see Priority 3.5 definition) or local supply is affected and private use is not prohibited and there are no barriers to use (e.g., underlays highway), especially in a rural setting. In urban or heavily developed areas where a major or minor aquifer, or local supply is not involved, the lack of historical use and the presence of municipal supplies lends credence to unlikely future use. Future use of groundwater may also be unlikely where there is a lack of historical use of the affected groundwater zone and there are prohibitions against the installation of water wells. When considering possible future use, primary focus should be placed on an evaluation of the downgradient direction, however, future use in close proximity to the upgradient or lateral extent of the plume can influence contaminant migration.
11. When considering potential for construction worker exposure, consider the location of existing utility corridors and Rights-of-Way. Additionally, consider the maturity of developed areas. Areas in the path of development should be considered likely areas for future utility construction.

Criteria are presented in the following table that can be used to judge when immediate exit from the corrective action program following a risk-based assessment may be appropriate with only a single sample event. Figures 1, 2 and 3 present decision flowcharts for closing sites which do not meet the immediate exit criteria, but current and future exposure potential is low. These criteria do not address special concerns or nuances with sites. Sites should only be closed following this process when there are no other concerns regarding the site. Figure 4 indicates which sites may be appropriate for a natural attenuation remedial solution.



### Potential Immediate Exit Criteria Following Risk-Based Assessment Single Sampling Event

Soils Only Impact	Soils and Groundwater Impact	Target Soil Concentrations Met <sup>a</sup>		Target Groundwater Concentrations Met <sup>a,c</sup>	Historical Release <sup>d</sup>	No Wells Within	No Surface Waters Within <sup>e</sup>	Municipal Water Supply Available <sup>f</sup>	Priority
		Human Health	Soil-to-Groundwater <sup>b</sup>						
x		x	x						4.2
x		x			x	500 ft	500 ft	x	4.2
	x	x	x	x	x	500 ft	500 ft	x	4.1
	x	x	x	x	x	1200 ft	1200 ft	x	3.5 <sup>g</sup>

a. No NAPL  
 b. Vertical delineation should be complete and appropriate, and demonstrate generally declining concentrations with depth. Additionally soil samples should be representative, and there should be no concerns regarding preferential pathways (e.g., fractured bedrock, karst).  
 c. Groundwaters must be Category I-III. If category IV groundwater, and Category III standards exceeded, then additional monitoring/evaluation warranted to ensure no other hazard.  
 d. Recent release could be considered if know of minor nature. Primarily considering sites which are likely static or declining conditions.  
 e. Groundwater/Surface Water interconnection should be likely.  
 f. The municipal supply is not the affected groundwater body.  
 g. Or local supply.

**Figure 1**  
**Groundwater Pathways** (See also Figure 2)

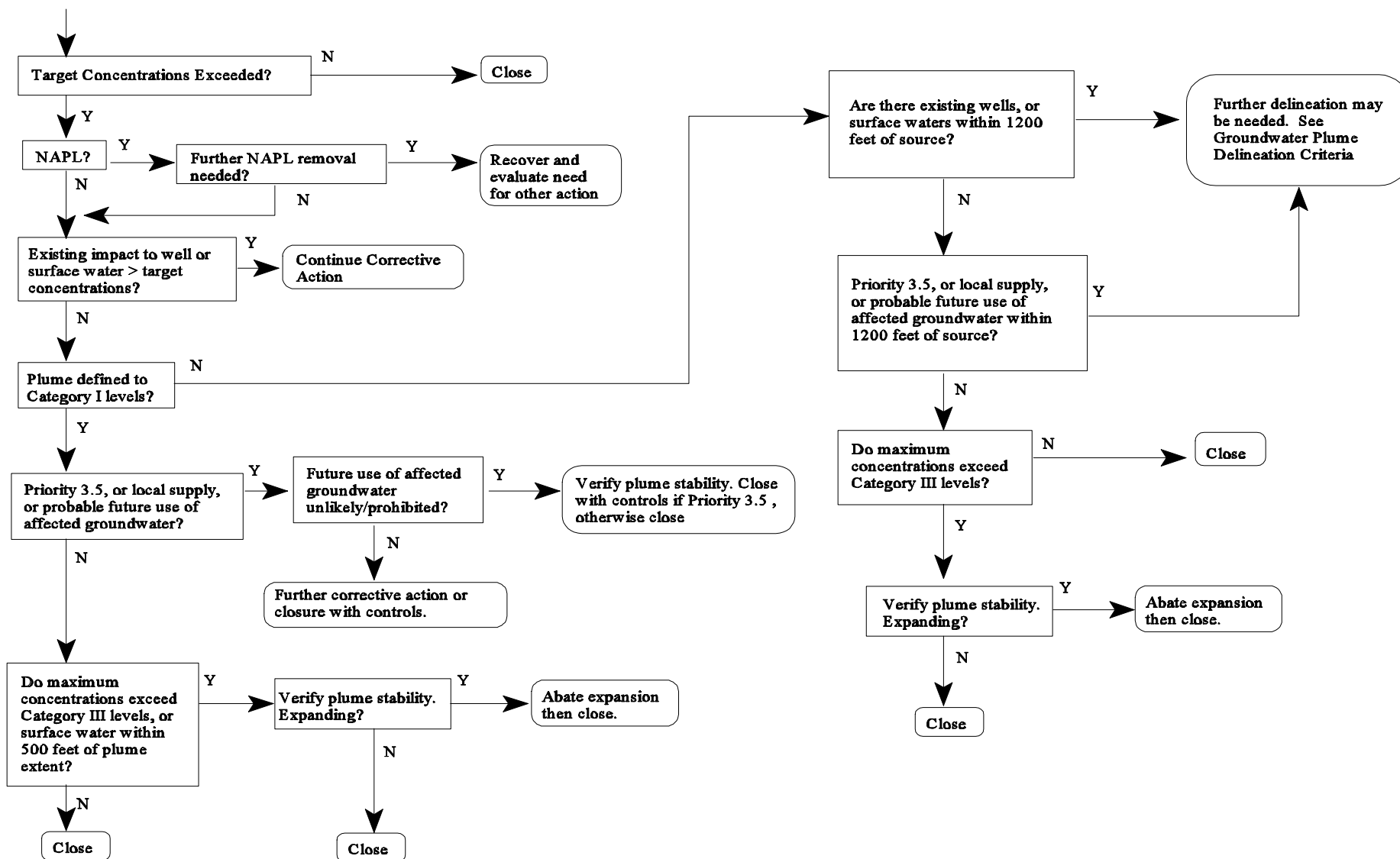


Figure 2

**Groundwater Pathway - Groundwater Depth  $\leq$  15 Feet, or Within Typical Construction Depth**

(Criteria for Figure 1 must also be met)

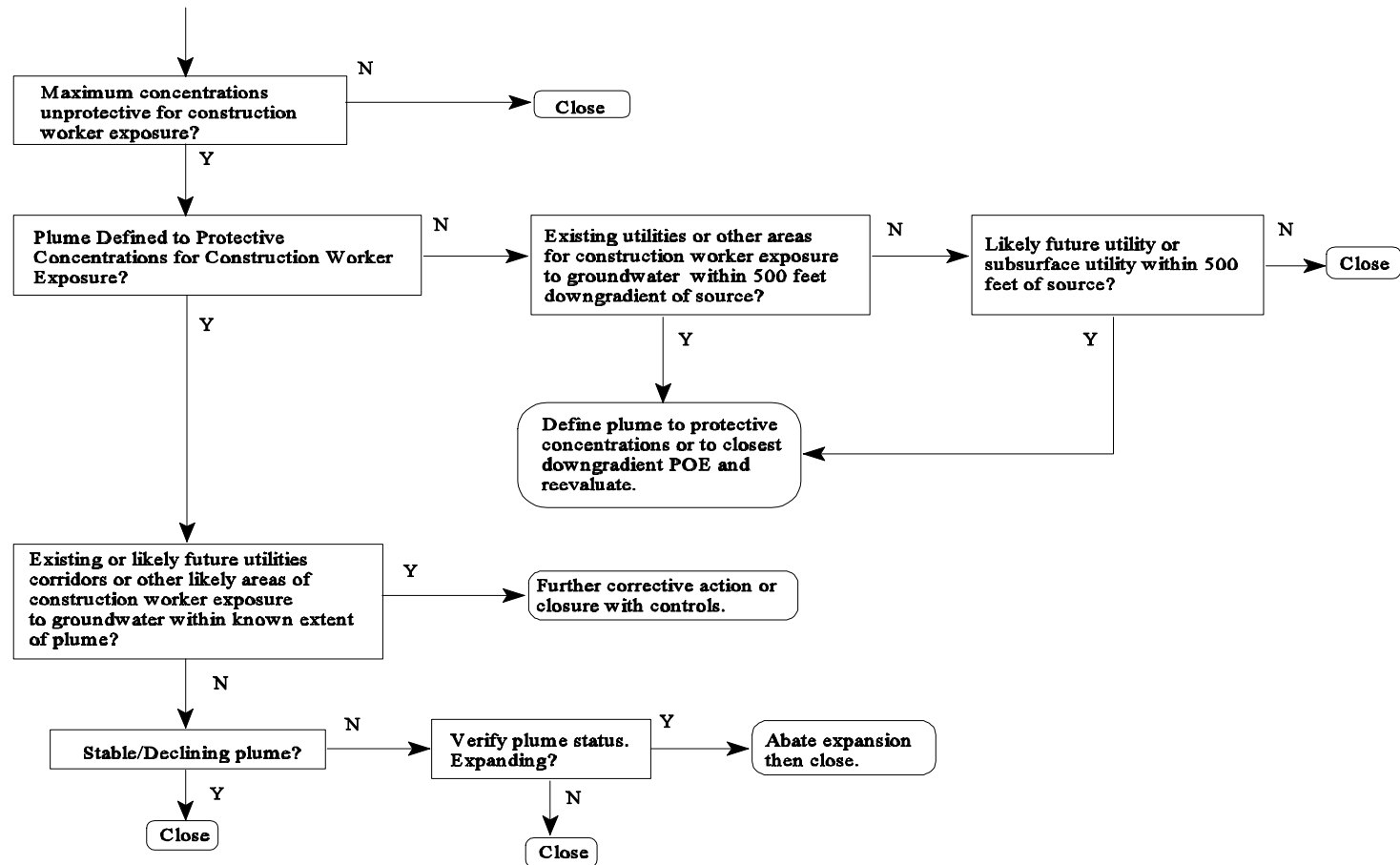
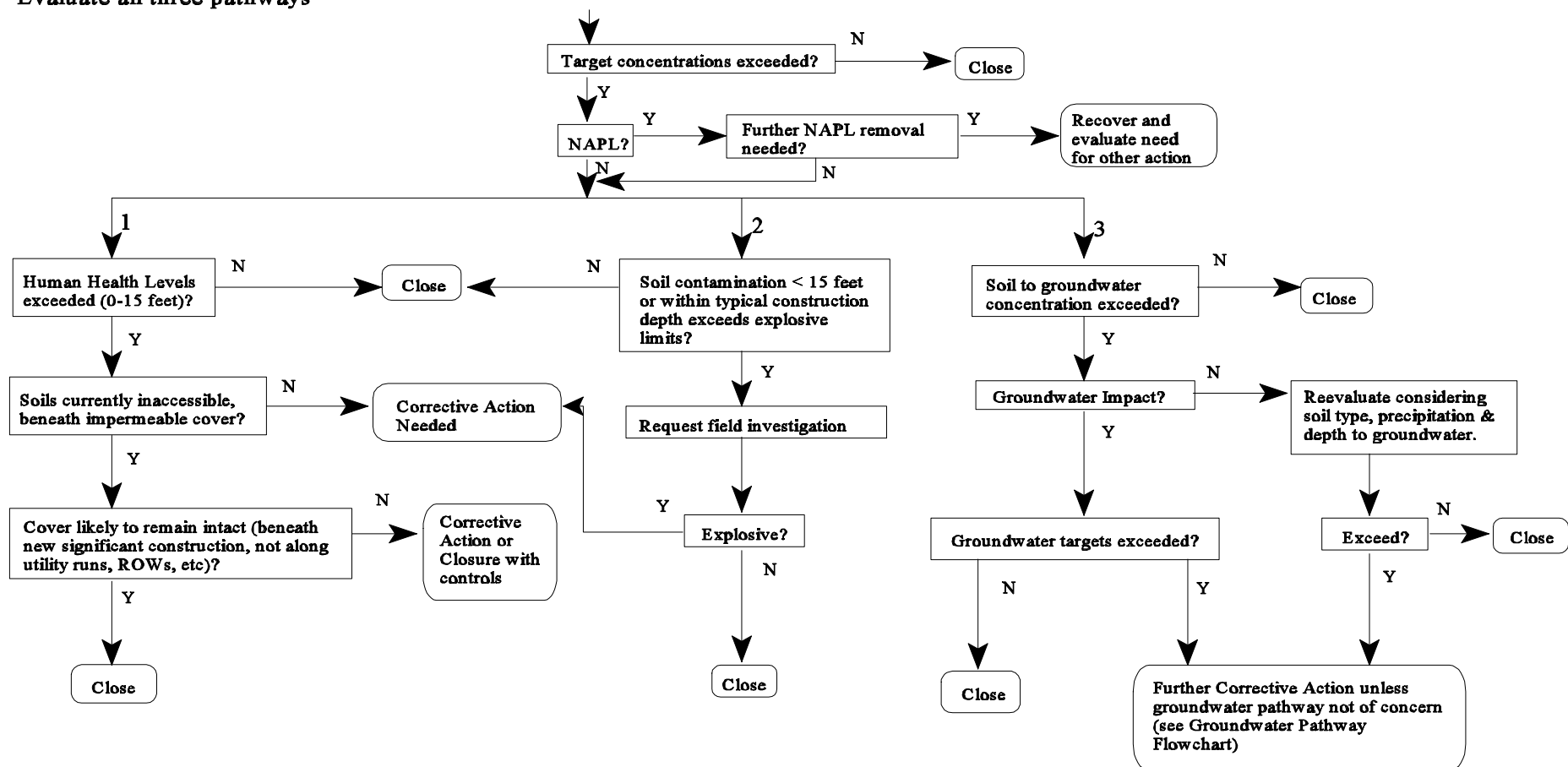


Figure 3

## Soils Pathways

Evaluate all three pathways



**Figure 4**  
**Criteria for Natural Attenuation Preference**  
**Petroleum Hydrocarbon LPST Groundwater Sites**

